HUDSON-RARITAN ESTUARY
ENVIRONMENTAL RESTORATION FEASIBILITY
STUDY

HARLEM RIVER/EAST RIVER/WESTERN LONG ISLAND SOUND

STUDY AREA REPORT

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U.S. Army Corps
of Engineers
New York District

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HARLEM RIVER/EAST RIVER/WESTERN LONG ISLAND SOUND

STUDY AREA REPORT

I. INTRODUCTION

Background

1. The New York District of the Corps of Engineers (the District) is conducting a feasibility study for ecosystem restoration in the Hudson-Raritan Estuary (the Estuary) – the Hudson-Raritan Estuary Ecosystem Restoration Study, herein referred to as "HRE". The study area is delineated as the Port District, an area surrounding greater metropolitan New York City within an approximate 25-mile radius of the Statue of Liberty (Figure 1). However, for purposes of ecological continuity the actual study area may include additional portions of this system beyond the man-made Port District boundary.

2. The overall goal of the HRE is to restore ecological function and diversity that have been lost or degraded as a result of human activities. The HRE will rely on both existing and newly obtained natural resource data to identify areas to be restored or conditions that must be addressed to assure successful ecosystem restoration. The two primary components of the study are the preparation of a Comprehensive Restoration Implementation Plan (CRIP) and the implementation of restorations/enhancements at various locations in the Estuary.

3. The purpose of the CRIP is to serve as a master plan that lays out a comprehensive and coordinated strategy that, when implemented, will guide the ecological restoration of the Estuary. The CRIP will establish a framework within which the actions needed for successful restorations can be holistically evaluated and planned. The plan will address actions to enhance, expand, recreate, and diversify natural habitats, and actions to eliminate constraints to ecological functions, such as sediment contamination. The CRIP will describe the strategy for restoration efforts that will include immediate, mid-term, and long-range options. It will also provide a central focus for public input, data collection, restoration efforts, and management actions and policies, regardless of who might have authority, desire and/or funds to undertake any action.

Study Area Delineation of the Estuary

4. To get a more manageable and understandable picture of the Estuary, its history of degradation, local needs and desires, potential restoration opportunities, and current restoration efforts will be documented in eight Study Area Reports (SARs). The study area boundaries are typically delineated by major watersheds and/or major physical features, such as highways or waterways. By and large, each study area can be characterized by its ecological functions, history of degradation, and resulting needs and opportunities. For example, Jamaica Bay, a historically expansive wetlands complex, has been subject to extensive fill and loss of wetlands; the Hudson River system, to hardened shorelines and contaminated sediment; and the Lower Bay contains coastal and offshore environments, experiencing loss of dunes and benthic habitat. Separating the project area into smaller study areas will enable the study team and potential stakeholders to address study area-specific restoration needs as well as individual restoration opportunities within each study area, and to collect and characterize data in a more usable and understandable way, all under the ultimate umbrella of the CRIP, which links the study areas into one major plan.

5. The eight study areas to be included in the CRIP are as follows (see Figure 1):

1) Jamaica Bay,
2) Lower Bay,
3) Lower Raritan River,
4) Arthur Kill/Kill van Kull,
5) Newark Bay/Hackensack River/Passaic River,
6) Lower Hudson River,
7) Harlem River/East River/Western Long Island Sound,
8) Upper Bay.

Purpose of the Study Area Reports

6. The identification of potential restoration opportunities in each study area will be a two-fold process. First, the District will identify potential restoration sites based upon a preliminary needs and opportunities survey of various interested groups/agencies conducted by the Regional Planning

Association (RPA) and presented in their Needs and Opportunities Report. This information will be supplemented by additional analyses of restoration needs and opportunities on a more local level. Study area needs will be determined based upon the causes of ecosystem degradation and the condition of existing natural resources in each study area. This effort is already underway (but far from completed) and potential restoration sites in the Harlem River/East River/Western Long Island Sound have been identified.

7. Second, the District will hold stakeholder meetings in each study area. The purpose of these meetings will be to incorporate additional comments from environmental organizations, community groups, and other individuals and stakeholders in each study area. This process will ensure the needs and opinions of as wide and diverse a group as possible is incorporated into the CRIP.

Format of the Report

8. This SAR addresses the Harlem River/East River/Western Long Island Sound study area (Figure 2). The **Study Area Description** section describes the setting, history of degradation, existing land/water usage, and existing natural resources in the study area. Restoration needs and existing restoration efforts are summarized in the **Ecosystem Restoration** section.

II. DESCRIPTION OF THE STUDY AREA

Setting

9. This report encompasses the Harlem River/East River/Western Long Island Sound study area. The Harlem River and East River comprise a tidal strait complex that merges with the Hudson River in the Upper Bay, connecting the Hudson to Western Long Island Sound. The Harlem River also connects to the Lower Hudson River through the Harlem River at Spuyten Duyvil, creating the island of Manhattan. The study area encompasses the Boroughs of Brooklyn, Queens, Bronx, and Manhattan, New York, as well as portions of Westchester and Nassau Counties, New York (Figure 2). Although the study area is highly urbanized, it contains the second largest expanse of open water habitat in the Estuary in Western Long Island Sound.

History of the Study Area

10. Prior to European settlement, the study area inhabited by Native Americans because of the diversity of the rich resources that were available. The area that is now Harlem was an important area because it provided not only an excellent supply of fish and game, but also provided access to freshwater sources.

11. European settlement in the study area began in the mid-1600's, when the Dutch and the French settled in the area that is now known as East Harlem. The early settlers used the land primarily for agricultural purposes. The conversion of farmland to residential development began in the 1800s. During this time, Randall's Island and Ward's Island, in the East River, were used as garbage dumps, cemeteries, and to house the poor. Ward's Island was also used to process immigrants until the late 1800s, when Ellis Island opened. In the 1930s, the islands were converted to parks and later joined using fill.

12. As urban development continued in the study area, nearly all of the uplands and wetlands areas were converted from farmland or forest to residential, commercial, or industrial properties and freshwater tributaries were filled or converted to storm sewers. The study area has been modified continuously over time and, with the exception of the Bronx River, no significant, natural freshwater tributaries remain. Virtually all of the shoreline along the East and Harlem Rivers has been filled, hardened or straightened.

Existing Land/Water Usages

13. Predominant land uses within the Harlem River/East River/Western Long Island Sound (HEW) study area consists of developed commercial, industrial, and residential land. Along the waterfront, land and water uses include commercial ferry terminals, marinas, marine parks, parkland, and residential land. Public parks and open space present in the study area include Alley Pond Park, Bronx Park, Pelham Bay Park, Pugsely Creek, Seton Falls Park, Soundview Park, and South Brother Island. A greenway along the Bronx River from Soundview Park (near the East River) to the Bronx Zoo is being planned by New York State Department of Transportation (NYSDOT).

14. Water is withdrawn from the East River and used as cooling water at power plants along the lower East River (Astoria, Poletti, Ravenswood and East River plants). Six sewage treatment plants (STPs) owned and operated by New York City Department of Environmental Protection (NYCDEP) (Red Hook, Newtown Creek, Wards Island, Hunts Point, Bowery Bay and Tallman Island plants) and four STPs in Nassau County (Belgrave, Great Neck, Village of Great Neck and Port Washington) discharge treated wastewater that is assimilated by the receiving waters. As stated previously, these waterways are used for commercial and recreational navigation and secondary contact recreation including water/jet skiing and fishing. East of the Throgs Neck Bridge, a public bathing beach, Orchard Beach, which is located near City Island in the Western Long Island Sound, is operated by the NYC Department of Parks and Recreation. In addition, several private beaches are located along Eastchester Bay and Little Neck Bay. New York City Department of Health (NYCDOH) monitors water quality at these beaches and when total coliform concentrations exceed their criterion, an advisory on bathing is issued until further testing shows compliance.

Natural Resources Condition

15. Historic inputs of toxic substances have degraded water quality and contaminated bottom sediments in the study area. The primary contaminants of concern in the study area are heavy metals, PCBs, and oil by-products. In addition, sewage and stormwater discharges have degraded water quality to the extent that portions of the Western Long Island Sound become hypoxic or anoxic at certain times of the year. Anoxic and hypoxic events in the study area are believed to occur from sewage effluent that, when discharged into the waters, causes algal blooms and

subsequent oxygen depletion. Leachate, containing toxic substances, particularly ammonia, from the Pelham Bay landfill has also contributed to historic water quality degradation in the study area.

16. The majority of the study area is highly urbanized; however, some undeveloped and/or natural areas remain. Due to urbanization, few freshwater tributaries, aside from the Bronx River, remain. As mentioned above, the majority of freshwater sources in the study area have been converted to sewer systems or are dominated by stormwater runoff.

17. The Harlem and East Rivers are important migratory pathways for fish because they connect Long Island Sound and the Hudson River. The quality of habitat for fish in these waterbodies is degraded because the majority of the shorelines have been straightened, bulkheaded, and/or filled. The piping of tributaries to the Harlem and East Rivers has resulted in culverted outfalls as opposed to natural confluences. The piping of the freshwater tributaries has also led to a significant loss of potential spawning habitat for anadromous fish in the study area.

18. Portions of the shorelines along Harlem River and East River have been "re-naturalized." In these re-naturalized areas, abandoned waterfront structures have subsided or deteriorated creating coves of littoral habitat where bulkheads and piers once stood. The shallow waters and sloping shorelines that have returned in these areas provide limited nursery habitat for fish and foraging habitat for waterfowl and long-legged wading birds (USFWS 1997). In areas where re-naturalization has occurred, local stakeholders have encouraged preservation of these areas and, where feasible, parks have been created or improved in the surrounding uplands.

19. Historically, the Bronx River watershed was an oak-dominated forest. The majority of the watershed was converted to urban land after the 1840s. Urbanization has led to habitat loss and the introduction of industrial pollutants to the river. Groundcover in the Bronx River watershed is dominated by impervious surfaces making it vulnerable to high stormwater flows and severe erosion (HEP 2001). In many areas along the Bronx River where natural shoreline remains, native vegetation has been replaced by invasive species such as common reed (*Phragmites communis*) and purple loosestrife (*Lythrum salicaria*).

20. Several undeveloped or uninhabited rocky islands exist within the East River, the largest and most significant being North and South Brother Islands. Once developed, these islands are now of ecological importance in the study area because they are important breeding grounds for colonial waterbirds. In addition to the natural regrowth, deteriorated structures and piers on the islands provide nesting habitat for double-crested cormorants (*Phalacrocorax auritus*), black-crowned night herons (*Nycticorax nycticorax*), snowy egrets (*Egretta thula*), great egrets (*Ardea alba*), cattle egrets (*Bulbulcus ibis*), and glossy ibis (*Plagidis facinellus*). These islands are home to the largest black-crowned night heron colony in New York State.

21. The value of Western Long Island Sound from an ecosystem perspective is primarily as an aquatic habitat due to the highly urbanized nature of the uplands and shorelines. Mean tidal range in the Western Long Island Sound is approximately 7.2 feet and the salinity is approximately 25 parts per thousand (ppt). The Western Long Island Sound provides important habitat for migratory and resident fish. Wetlands and sand beaches in this portion of the study area provide significant wildlife habitat. A few of the more ecologically significant areas within Western Long Island Sound include Little Neck Bay, Manhasset Bay, Hempstead Harbor, and Pelham Bay.

22. A large proportion of former wetland areas have been filled for urban or industrial land uses such as residential development and landfill (e.g., Pelham Bay Landfill). The wetland systems that remain are predominantly intertidal wetlands that exist along creeks, rivers, and in nearshore areas. Many of the remaining wetlands have been disturbed at some point in time, which has given invasive species, such as common reed the opportunity to become a dominant species. Areas that remain subject to adequate tidal flushing are dominated by smooth cordgrass (*Spartina alterniflora*) and salt meadow cordgrass (*Spartina patens*) remain.

23. Despite the degradation within the study area, the wetlands and/or sand beaches that remain in areas including those found in Little Neck Bay, Manhasset Bay, and Hempstead Harbor serve as important waterfowl wintering areas in the Estuary, especially for scaup (*Aythya marila, A. affinis*), canvasback (*Aythya valisineria*), and American black duck (*Anas rubripes*). The bays also are important nursery and foraging habitat for marine finfish, including striped bass (*Morone saxatilis*), scup (*Stenotomus chrysops*), bluefish (*Pomatomus saltatrix*), and winter flounder (*Pleuronectes*

americanus). Little Neck and Manhasset Bay and Hempstead Harbor also contain important northern quahog (*Mercinaria mercinaria*) beds. There are a limited number of beaches in the Western Long Island Sound. Although the existing beaches are small in size, they provide important nesting habitat for piping plovers (*Charadrius melodus*), a federally listed threatened species, least tern (*Sterna antillarum*), and northern diamondback terrapin (*Malaclemys terrapin terrapin*). Rocky offshore islands also exist in the study area. These islands support colonial waterbird colonies of regional significance (USFWS 1997).

III. ECOSYSTEM RESTORATION

Hudson-Raritan Estuary Ecosystem

24. The New York-New Jersey Harbor Estuary Program (HEP 1996) has identified five primary factors that have caused ecosystem impairments or otherwise degraded water or habitat quality in the Estuary. These factors are:

- Habitat Loss and Degradation: Recent wetland inventories estimate at least 80% of the Estuary's wetlands have been lost or significantly altered.

- Toxic Contamination: The presence of toxins in the Estuary's waters, sediments, and biota is the result of historic and residual contamination by industrial and non-point sources. Today, wastewater discharges, combined sewer overflows (CSOs), accidental releases, vehicle exhaust emissions, household chemicals, pesticides, atmospheric deposition, landfill leachate, urban runoff, and other non-point sources are continuing sources of toxic substances (HEP 1996).

- Pathogens: The primary sources of pathogens include CSOs, sewage treatment plant malfunctions, illegal connections to storm sewers, vessel sewage discharge, urban runoff, and other non-point sources.

- Floatable Debris: Floatable debris is made up of two primary components: trash or litter and harbor drift. Trash and litter enters the Estuary via runoff, storm sewer discharges, CSOs, beach and boat litter, and poor solid waste handling operations. Harbor drift composed primarily of material from dilapidated shoreline structures such as piers, bulkheads, and pilings, is a significant of floatable debris in the Estuary.

- Nutrient and Organic Enrichment: Eutrophication due to excessive discharges of nitrogen is a significant problem in the Estuary. Organic matter comprised primarily of carbon is decomposed as DO and used in the biochemical process. Nitrogen and carbon enter the Estuary through point and non-point sources such as sewage

treatment plants, runoff (primarily from over-fertilized lawns), rivers and tributaries and atmospheric deposition.

Primary Restoration Needs of the Hudson-Raritan Estuary

25. The overall goal of the HRE is to restore and enhance aquatic and nearshore terrestrial habitats that have been lost or degraded as a result of human activities. To achieve this goal, primary restoration needs of the Estuary have been established. These categories were identified in the document entitled *Restoration Opportunities in the Hudson-Raritan Estuary* (USACE 2001). These need are:

- Restore and create intertidal wetlands and mudflats,
- Restore benthic habitats and remediate "hot spots" of contaminated sediments,
- Restore and create freshwater/riparian wetlands,
- Restore fish habitat (remove impediments to fish passage; construct artificial reefs),
- Restore shellfish habitat,
- Restore and enhance shoreline/coastal fringe habitat (including upland areas),
- Create, restore, or enhance vegetated and non-vegetated shallow water habitat.

Restoration Needs of the Harlem River/East River/Western Long Island Sound

Wetlands Restoration/Creation and Removal of Invasive Species

26. There are two primary restoration needs for the study area. First, due to extensive urbanization and filling of freshwater habitats, freshwater and riparian wetlands should be restored and created. The best opportunity for freshwater wetland and riparian wetland restoration is along the Bronx River corridor. Implementing such opportunities will improve riparian habitat and could provide connections to freshwater resources that currently do not exist. Connecting fragmented habitats could be particularly beneficial to migratory bird species.

27. Second, degradation of salt marshes and invasion by non-native species has created a need for restoration in coastal salt marshes. By restoring degraded areas and improving tidal flow to areas formerly flooded by the tides, native salt marsh vegetation can be used to replace invasive species such as common reed. Restoration of tidal wetland habitats could improve foraging habitat for wading birds. In addition, creation of low marsh habitat will provide nursery habitat for fish in the study area.

Restore River Habitat and Soften Shorelines

28. There is a need to restore riverine habitat within the study area. Many of the shorelines have been hardened or filled, thereby reducing habitat for fish and foraging habitat for wading birds and waterfowl. Additionally, vegetated shorelines help improve water quality by trapping sediment in runoff and reducing the potential for erosion. Restoration of riverine habitat can be achieved by removing debris and structures that restrict tidal flow and fish movement. Shorelines can be softened and renaturalized through the removal fill and derelict bulkheads and piers and planting of native vegetation.

Remediate Leachate Sources and Contaminated Sediments

29. Efforts should be made to identify and remediate leachate sources that remain in the study area. Leachate recovery and treatment systems could be installed to treat contaminated leachate from former landfills and industrial sites where groundwater contamination contributes to water quality problems.

30. Several options exist in areas where contaminated sediments are a problem. One potential is to cap areas of contaminated sediments using clean dredge material. Another option is to remove the contaminated sediments by dredging and replacing the sediments that were removed with clean dredge material. Contaminated sediments that are removed from waterbodies within the study area could then be treated and used in upland locations. For example, the treated sediments could be used to cap landfills or brownfield sites.

Restore and Enhance Upland Habitat

31. Restoration efforts in upland habitats can result in indirect improvements to water quality. Vegetated upland areas help to slow surface water runoff and trap sediments and potential contaminants that are present in urban stormwater runoff. Upland restoration also has the potential to improve or create additional habitat for terrestrial wildlife in the study area.

32. Upland restoration efforts also have the potential to benefit colonial nesting waterbirds such as herons and egrets. Many of these species nest on offshore islands where invasive species are replacing native species that are favored for nesting. Gulls and terns may benefit from the creation of upland areas characterized by sand and gravel substrate and sparse vegetation. This type of habitat can be created through efforts such as the deposition of clean dredge material of the appropriate texture.

Existing Restoration Efforts

33. Habitat restoration projects have been undertaken in the study area and various organizations, most notably, the Harbor Estuary Program (HEP) Habitat Workgroup, have identified additional potential sites and sought to promote restoration efforts. The following habitat restoration initiatives have been completed or are proceeding in the study area.

Alley Pond Park (Alley Creek)

34. Alley Creek, in Queens, flows from Oakland Ravine in Alley Pond Park to Little Neck Bay, Long Island Sound. The creek, in its entirety, is contained within the park. Freshwater input from stormwater runoff and CSOs coupled with input of fill materials have degraded tidal wetlands and areas above the tidal inundation level are dominated by common reed. To alleviate most of the problems associated with CSOs, the NYCDEP is constructing a five million gallon CSO retention facility. Construction of the project began in 2003 and the CSO retention facility will start operating in 2008. A tidal wetland restoration surrounding the CSO storage conduit, which is located along the west-descending bank of Alley Creek, will be constructed in the final phase of NYCDEP's project.

Pelham Lagoon/Turtle Cove

35. Pelham Lagoon/Turtle Cove, located in Bronx, New York City, New York, was once a contiguous stretch of open water and tidal marshes. The area was filled to create roads connecting the Pelham Bay Parkway to City Island and the Hutchinson River Parkway to Orchard Beach. Turtle Cove is connected to an impoundment between the City Island Road and Orchard Beach Road in Pelham Bay Park. The impoundment is characterized by open water, small tidal marshes, and uplands dominated by common reed. The impoundment, referred to as Turtle Cove Pond, is hydraulically connected to Turtle Cove, which is within Eastchester Bay, via a culvert under City Island Road. An embankment that at one time served as a bridle path prevents tidal exchange between the Turtle Cove Pond and a northern impounded area that is dominated by common reed. Currently, NYSDEC is conducting a feasibility study for a tidal wetland restoration project that would involve restoring the hydraulic connection between Turtle Cove Pond and the northern impounded area.

Sherman Creek

36. Sherman Creek is located in Manhattan, New York City, New York. The creek is a small embayment in the Harlem River that has been filled along most of its length. The remaining reach was dredged to allow coal barge deliveries and slag removal at an adjacent power plant. The western and southern shorelines were used as a marina from the early 1900s through the 1980's. Outflow from the power plant maintained the remaining channel. However, the plant closed in the 1970's and the boat basin is subsequently being filled with sediments from the Harlem River.

37. The New York City Parks Department recently removed deteriorated piers and abandoned vessels down to the mudline within the creek embayment. In addition, the New York City Parks Department is constructing a wetland restoration project and park on the property just south of the creek.

Tallapoosa

38. Tallapoosa is also located in Bronx, New York City, New York. This site is a former tidal wetland that has been altered as a result of the construction of surrounding transportation

infrastructure (roads and railroads). Almost all of the former tidal wetlands at the site have been filled. Approximately 20 acres of wetlands and mudflat remain at this site. Tallapoosa is also characterized by a small freshwater pond and wetland fringe. A stone lined drainage ditch also traverses this site. Runoff through the ditch is creating erosion in portions of the remaining tidal marsh.

39. The New York City Parks Department conducted a tidal restoration project at the site in 1999. The project encompassed less than 0.5 acres of high marsh wetlands and mudflat at the western extent of tidal influence. The NYSDEC is currently conducting a feasibility study for the restoration of the freshwater pond and surrounding wetlands, which are dominated by common reed. The agency is also exploring the possibility of restoring tidal wetland areas, many of which are also dominated by common reed.

Bronx River Restoration Efforts

40. The Bronx River Working Group is accomplishing watershed restoration and protection efforts in the Bronx River Watershed by acquiring land, restoring river channel hydraulics, stabilizing eroding riverbanks, and reclaiming wetlands and floodplains (Clean Water Action Plan 2003). Included within the Bronx River Working Groups efforts is a restoration project at Soundview Park that is authorized under Section 1135 of the Water Resources Development Act. The District is currently conducting a feasibility study for the restoration of approximately 40 acres of tidal wetlands at this location. Restoration efforts in the Soundview section will also include combined sewer overflow abatement, establishment of a new parks, and introduction of community stewardship initiatives.

Bronx River Feasibility Study

41. In addition to their efforts at Soundview Park, the District is preparing to undertake a feasibility study for an ecosystem restoration study in the approximately 56-square mile Bronx River Watershed. Brainstorming sessions held with local stakeholders led to the identification of 18 potential ecosystem restoration sites. The study is expected to begin in December 2003.

Potential Restoration Sites

42. In addition to the existing and on-going restoration efforts, 34 potential restoration sites have been identified in the Harlen River/East River/Western Long Island Sound study area and are listed in Table 1. Each site not currently under study or construction will be evaluated to determine which of the proposed restoration activities, if any, are feasible from an engineering, ecological, and economic perspective.

Table 1 - Potential Restoration Sites in the Harlem River/East River/ Western Long Island Sound

HRE Site ID	Name	Restoration Opportunities[(1)]
1HEL	Tibbets Brook	3,6,8
2HEL	Hutchinson River (Marsh Restoration)	1,6,7,8
3HEL	Hutchinson River (Fish Impediment Removal)	4
4HEL	Hutchinson River	1
5HEL	Pelham Bay Lagoon / Turtle Cove Complex	1,6
6HEL	Tallapossa West (Point)/Pelham Bay	1,4,6
7HEL	Pelham Bay Landfill	1,6
8HEL	Sherman Creek	1,7,8,9
9HEL	Rice Stadium Wetlands	10
10HEL	City Island Wetlands	1
11HEL	Hart Island	1,10
12HEL	Palmer Inlet	1,6,10
13HEL	Ferry Point Park	1
14HEL	Pugsley Creek/Seton Falls Park	1,6,8
15HEL	Soundview Park	3,8
16HEL	Bronx River/Bronx Park	1
17HEL	Oak Point Rail Yard	8,9,10
18HEL	Hempstead Harbor	6
19HEL	Udalls Cove	1,6
20HEL	Aurora Pond	1,6
21HEL	Alley Pond Park	3,9
22HEL	Powells Cove	1,3,4,6,7
23HEL	Flushing Creek and Bay	1,6
24HEL	Meadow Lake	1
25HEL	Bowery Bay	3,9
26HEL	South Brother Island	1,10
27HEL	Little Hellgate Wetlands	1,6
28HEL	Hallets Cove	1,10
29HEL	Anable Cove	*
30HEL	Newtown Creek	11
31HEL	Stuyvesant Cove	2,4,6,7
32HEL	Bushwick Inlet	11

HRE Site ID	Name	Restoration Opportunities[(1)]
33HEL	Cove between the Bridges-Part of Brooklyn Bridge	1,6,7

(1) Restoration Opportunities:
1 – Restoration/Creation of Intertidal Wetlands/Mudflats
2 – Benthic Habitat Restoration (Hotspot Removal)
3 – Restoration/Creation of Freshwater/Riparian Wetlands
4 – Restoration of Fishery Habitats (Anadramous Fish Migration, Artificial Reefs)
5 – Shellfish Habitat Restoration
6 – Restoration/Enhancement of Shoreline/Coastal Fringe Habitat (Dunes, Bird Habitat)
7 – Creation/Restoration/Enhancement of Shallow Water Habitat (including Eelgrass)
8 – Shoreline Enhancement/Bank Stabilization
9 – Water Quality Improvement
10 – Riparian Habitat Restoration
11 – Environmental Interpretation
* To be determined

IV. CONCLUSIONS

43. In addition to the existing and ongoing restoration efforts, 24 potential restoration sites have been identified in the Harlem River/East River/Western Long Island Sound study area and are shown in Table 1. Each site will be evaluated to determine which of the proposed restoration activities, if any, are feasible from an engineering and economic perspective.

44. The Harlem River/East River/Western Long Island Sound study area is a diverse area. Western Long Island Sound provides a large open water area with diverse substrates and habitat types. This open water is second only to the Lower Bay study area. The study area encompassing the East and Harlem Rivers and Western Long Island Sound is an important component of the Estuary in that it provides migratory pathways between the Hudson River, Upper Bay and Long Island Sound. Improving water quality over the past several decades has restored and maintains the pathways for use by aquatic life during all seasons. The restoration and enhancement of shoreline habitats and tributary creeks can now provide habitat for adults and juveniles of the migratory and transitory species moving through the study area, and will also support the indigenous biota. The East River provides a connection at the transition point between New England and mid-Atlantic marine coastal waters. While the lower Harlem River and East Rivers have limited opportunities for shoreline restorations, the Upper East River and western Long Island Sound have extensive areas for habitat restoration work. Restorations in these areas have the potential to contribute to recreational opportunities in the public parks in this study area.

45. Like other study areas in the HRE, the Harlem River/East River/Western Long Island Sound study area has lost or experienced significant reduction in natural sources of freshwater input. Therefore, there is a great need to restore freshwater habitats formerly associated with these stream corridors. Opportunities to explore such restoration needs should focus on areas where remnants of freshwater ecosystems still exist.

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FIGURES